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From

Sir Arnold Wilson.

To

A Souttar Esq.

M. R. C. S.

Nov. 1938

Observations physiological and
chemical —

ON
COMPOUND FRACTURES.

CONTAINING,

An ANSWER to the following Question :

“What are the best methods of treating Compound
Fractures, according to the degree of injury sustained by
the limb?”

By WALTER WELDON, *Surgeon.*

“ Similis rursus ex magna parte casus curationesque sunt humeris et femoribus. Communia etiam quaedam humeris, brachiis, femoribus, cruribus, digitis.”

SOUTHAMPTON,
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TO
DR. WILLIAM SAUNDERS,
FELLOW OF THE COLLEGE OF PHYSICIANS,
OF THE ROYAL SOCIETIES OF LONDON
AND EDINBURGH,
AND SENIOR PHYSICIAN TO GUY'S HOSPITAL.

DEAR SIR,

I Embrace with pleasure this opportunity of acknowledging my obligations for the advantages I obtained from you during the prosecution of my studies, and of expressing the high respect I entertain for your private, as well as for your professional character.

I have the honor to be,

DEAR SIR,

Your most obedient humble servant,

W. WELDON.

ADVERTISEMENT.

THE observations in the following pages were put into the form of an essay in answer to the annual prize-question of the Lyceum Medicum Londinense for the year 1792. Had they not met with the attention of that society, they would not now be sent before the public tribunal.

This essay is not to be considered as an attempt even at a complete treatise: it is only a collection of observations which have been made as occasion offered; and which were intended originally merely for my private use. The subject of it, from its frequent occurrence, and the confinement and danger that often attends it, is of great importance to mankind. And although it has attracted much of the attention of most surgeons of eminence, yet I believe it will be found susceptible of very great improvement. How far this little work may contribute to that end, my professional reader will judge.

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The producing of union by adhesive inflammation, it is well known, is not new. But of this I am certain, that very little attention has generally been paid to it in proportion to the chance of success and the probable advantages to be derived from it. And where I have seen it attempted, the manner in which the limb was dressed was such, that any person acquainted with the principle by which the living actions produce it, must know that it could not take place, unless by mere accident.

Compound fractures have frequently been treated on. The principles by which union is produced are now very well, though not very generally understood. Consequently many of the observations in the following pages are not new. But I have stated nothing of which I have not received conviction, either from a consideration of the laws of the human machine, occasional experience, or an attentive observation of facts. I am too well acquainted with the weakness of the human mind even in the greatest of us, to hazard any opinion merely upon the authority of another.

In a certain publication, in which my essay on the different modes of puncturing the bladder, &c. is noticed, it is asserted that the observations and arguments in that publication are strikingly similar to those which had before fallen from Mr. CLINE, of St. Thomas's hospital, in his lectures on the same subject. I believe the writer
never

never heard that gentleman. It is very well known to all Mr. CLINE's pupils, that he treated of this operation, and of the diseases of the bladder, very cursorily, and indeed the extensive plan of his lectures rendered it necessary ; that he took no notice of the disadvantages, or of the advantages arising from the different diseased states of the parts concerned in the different modes of operating ; that he condemned the operation per anum as always improper, and the operation supra pubes as very objectionable ; and that he recommended the operation in perinæo as universally the best. Had I been sensible of deriving from this gentleman, or from any other person, any matter on this subject with which the public were unacquainted, I, in justice to my own character, should have mentioned it.

SOUTHAMPTON,
MAY 19, 1794.

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CHAP. I.

INTRODUCTION.

“**W**HAT are the best methods of
“treating compound fractures, ac-
“cording to the degree of injury sustained
“by the limb?”

By a compound fracture (I suppose) is meant, the division of a bone in two or more pieces, connected with a wound in some of the surrounding parts.

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sustained by the limb," it appears that the question is confined to compound fractures of the bones of the extremities : to these, therefore, I shall confine my observations in the following essay.

When, from external violence, a bone is fractured, and the surrounding parts lacerated and torn, the objects of surgery are, to prevent the subsequent inflammation becoming so great as to destroy life, and (if possible) to restore the limb to its healthy state and function.

To effect this, we (to use a common phrase) must assist nature. In other words, there belongs to animal bodies an internal power of action. The effects which this power produces, are very much influenced by the operation of external agents, applied either locally or to the whole system. Had a limb that is fractured no internal power of action, it must ever remain as the accident leaves it : the assistance of surgery would be
vain.

vain. But a change is very soon observed to commence : an inflammation comes on : and it is in the management of this inflammation that the business of the surgeon consists.

This power of action in animal bodies is called, simple life.

Till of late years, very little notice appears to have been taken of it by the generality of surgeons, or physicians, or even of physiologists ; and those few who have noticed it, seem to have entertained very vague and confused ideas concerning it. It was brought into notice, principally, by the labors of Mr. John Hunter ; and is now pretty generally taught in the schools of London. Daily experience, however, convinces me, that neither this power of action, nor its effects, are by any means generally known ; and that very erroneous ideas are entertained, by many, concerning it.

In treating compound fractures upon a rational plan, a knowledge of the properties depending on the life of the part, is as necessary as the knowledge of those depending on the matter, if not more so. Therefore, I beg leave to offer some explanation of these properties, so far as their agency appears concerned in the subject before us, or as the consideration of them appear necessary to render the sense in which I use the term 'life' precisely understood.

This work being intended rather for the use of the younger part of the profession, and of those practitioners whose opportunities for observation are but few, I hope will be a sufficient apology to such of my readers as may think any explanation on this subject unnecessary.

An animal body, whilst alive, possesses a power of resisting those changes which chemical attraction has a tendency to produce
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in it. It has a power, also, of producing within itself such changes as are necessary for its growth, its nourishment, its various secretions, its restoration from mechanical injury, and for a variety of other functions.

Upon what this power depends ; whether upon any unknown peculiarity in the structure of animal matter ; or upon the agency of some unknown principle connected with this matter ; or whether we have any idea of its cause or not ; it is unnecessary, in this place, to insist. That such a power does exist, (I believe) no one who credits the testimony of his senses will deny : that it may, with great ease, be destroyed ; and that, when destroyed, it cannot be restored by human art ; is as evident. This power I call life.

It does not appear to consist in organization : it is not, at least, that organization which is subject to our senses. It exists not only with a great diversity of organization,
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but, also, without any that is apparent : as in the blood, for instance ; in the albumen, and yolk of eggs : and life may be removed by means which cannot, immediately, affect organization.

Neither does it appear to consist in any chemical property of matter ; for living matter is not subject to the laws of chemical attraction : on the contrary, although placed in circumstances the most favorable for their operation, (being exposed to the proper temperature and moisture, and the application of an external agent,) it is constantly resisting them ; but the moment life is removed, fermentation (which is a chemical process) takes place, and putrefaction is produced.

Nor is red blood ; nor are brain and nerves, and the sensation consequent thereon ; nor is intelection ; necessary to simple life. Animals are found, in which none of these can be traced : indeed, it extends to
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the whole vegetable part of the creation, in which their presence is not suspected.

It appears, at the same time, that living, animal matter (which is not vascular) is easily deprived of its life; and is capable of performing very few actions:---I think it is incapable of performing any. I will attempt to illustrate my meaning with an example.

A new-laid egg is capable of resisting the chemical action of the surrounding air. On the application of a certain stimulus, it is capable, also, of undergoing such a change that a chick is produced. Mr. Hunter says, that it resists the action of cold, to a certain degree: but the experiments of Mr. Haigh-ton (lecturer on physiology at Guy's hospital) contradict this assertion. Indeed, considering the manner in which animal matter resists the action of external cold, the power of an egg, in this respect, must be very weak, and also confined to a small part of it.

Either

Either of the above properties prove that the egg possesses life.---There is the strongest presumption that they depend on one and the same cause : remove the one, and the other is removed. On examining the component parts of the egg, it is found that the yolk and albumen are not vascular ; nor are they of a consistence to admit of what is anatomically called organization. It is found, also, that, during the process of incubation, they produce no change within themselves ; and that their life has no other effect than that of preserving them from putrefaction, whilst they serve the purpose of affording proper matter for the formation, and nourishment of the chick.

The embryo, in its earliest state, is so extremely small, and so tender in its structure, as to elude our examination : therefore, it cannot be asserted positively that it is vascular ; although there can be little doubt
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of it being so, and of its having derived this vascularity from the mother.

If these propositions are just, it appears, that life being present in unorganized animal matter, gives it a power of self-preservation, but not a power of action; and that organization is necessary to action. It appears also, that animal matter may possess life and organization, and yet be free from action; that a stimulus is necessary to produce action, and to continue it when produced: this is remarkable in eggs, prior to incubation; and in torpid animals, whose actions are in great measure dormant in severe cold.

Although simple life is, in some instances, found to exist in a mass of apparently unorganized animal matter, it is more generally found connected with matter completely organized; and this organization cannot be destroyed, without destroying life.

life. Animals having red blood, cannot be deprived of more than a certain proportion of it, without being deprived of life also. In the more perfect animals there are a variety of functions intimately connected with life, and absolutely necessary for its support, which depend, in great measure, on the agencies of chemical attraction, and the mechanical properties of matter.

In what manner any peculiar action produces its effects, or in what it differs from another peculiar action, human faculties do not appear sufficiently extensive to ascertain : we judge that actions differ, because we find that their effects differ. As the material and living principles seem to be the same in all animal bodies, it is probable that a difference in the actions depends on a difference in the organization of parts : but this is very clear, even to the most superficial observer, that all those actions de-
 pending

pending on life are perfectly different from any chemical or mechanical actions, and cannot be imitated by them.

We find, not only parts differently organized performing different functions, but even the same part performing different functions : thus, the liver produces bile; the salivary glands, saliva; &c. At the same time, an action goes on in these parts, producing the matter whereof they are composed; (for they are continually undergoing changes :) their matter is gradually removed by the absorbents, and fresh matter deposited in its place.

When the power of action exists, actions are capable not only of being produced by the application of a stimulus, but when produced they are capable of being increased, and even changed, by applying an additional stimulus: and if the additional stimulus be not too violent, upon removing it,

the increased or altered action will be removed. This law is a wise provision of our Creator: upon it depends all the powers of restoration in animals. In a limb, for instance, a variety of actions are going on for the preservation of it, and to enable it to perform its various functions. If by any violence a solution of continuity is produced, either in the soft parts or in the bone, this proves a stimulus; the actions are increased, and probably changed, at least new effects are produced: a quantity of coagulable lymph is thrown out, which, if the parts are retained in contact, forms a connecting medium between them, becomes vascular, and gradually takes on the structure of the adjacent part. The limb being thus restored to its former state, the stimulus ceases, and with it the increased or altered action. Or, if restoration is not thus produced, the stimulus continuing increases

creases the inflamed action further, or a still different action arises; pus is formed; and new flesh or bone appears, in the form of granulations: these gradually rising fill up the cavity, and unite the parts: then the stimulus ceases, and the actions return to their former state. But the stimulus may be too great. The actions may be increased to so violent a degree as to destroy the organization: then all action ceases, and the part dies.

Thus we see that the same part is susceptible of different actions, and degrees of action, in consequence of the application of different degrees of stimuli; that some of these actions tend to its restoration, others to its destruction. But mechanical, and even chemical stimulants, may be so violent as instantly to kill a part, before any change in the living actions can take place.

Besides

Besides the kind of actions noticed above, and which perhaps may be termed simple actions, an animal body, the human more particularly, is subject to a very great variety of complicated actions, giving rise to that multitude of diseases to which we are liable. As we know so little of the healthy actions of the animal economy, excepting by their effects, it is by no means surprising that we know little or nothing of its diseases, excepting by their effects also.

Man is the most perfect, by consequence the most complicated part of the animal creation. In him simple life is intimately connected with matter under a great diversity of organization, giving rise to a still greater diversity of actions. He has a large quantity of red blood. In his system a variety of functions are performed, wherein the agency of chemistry, and of mechanism are necessary. The proportion of his brain
and

and nerves is very considerable; his sensations are acute; the power of sympathy over his system is very great; the influence of habit no less so. In addition to these, he has an imagination that is generally lively; a strong recollection; and the faculty of reason.

These are all intimately connected together; no one can be affected, in any considerable degree, without more or less affecting the rest, and frequently endangering the destruction of the machine.

CHAP. II.

SOME OBSERVATIONS ON THE ECONOMY
OF THE BONES.

HAVING in the last chapter explained what I mean by the term 'simple life,' and hazarded a few observations on the animal economy in general, I proceed to consider some part of the economy of the bones. I shall confine myself to those observations which occur to me as connected with the subject before us.

The bones I consider as living, organized parts. Like other living parts, they are susceptible of a variety of actions, both healthy and diseased.

This

This doctrine will to many probably appear new, as formerly the economy of the bones was very little understood. It was supposed, that the bones were susceptible of no change, or disease, but that of becoming carious ; every disease occurring in them was supposed to be a caries. It is principally to the labors and ingenuity of Mr. John Hunter, that the world is indebted for an explanation of the economy, and of the diseases of bones ; by consequence for that improvement in their surgical treatment, which such a knowledge naturally points out.

The structure and organization of bones differ, in several respects, from those of other parts. It is observed above, that a difference in organization is the cause of a difference in action. Accordingly, the actions, both healthy and diseased, which take place in bones, differ in several respects

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from those which take place in the other parts of the body.

To enumerate all the actions which take place in bones, is to enumerate most of the general actions, healthy and diseased, which occur in other parts of the human body; and to point out those peculiarities which are the consequence of their peculiarity in structure. Indeed I think it would be unnecessary, in this place, to enumerate any, were it not that many surgeons still entertain very erroneous notions, not only of the diseased actions to which bones are liable, but of those actions also which are necessary to restore them to an healthy state.

The living powers of the different parts of the human body are, generally speaking, in proportion to their vascularity; and if we except those which are newly formed, as cicatrices, callus, &c. parts possessing less vascularity are generally less susceptible
of

of diseases; but when diseased are more difficult to manage.

The bones are less vascular than most other parts; their living powers also are much weaker; the quantity of earth contained in them renders them much firmer, and more resisting in their structure. In consequence of these differences, it is very generally found that

1. The bones are less susceptible of diseased actions than the softer parts; and when diseased, require more care, and attention in the treatment.

2. All the actions, healthy and diseased, taking place in bones, are slower in their progress than similar actions taking place in soft parts.

3. The diseased actions of bones are more liable to produce death in them, than those of soft parts.

But it is observable, that the bones differ considerably in structure; some being very

D 2 cellular

cellular, and vascular, containing a comparatively small proportion of earth; others being very close in their texture, containing but few vessels, and a comparatively large proportion of earth.

The cellular part of bones is more susceptible of constitutional diseases. These diseases make a more rapid progress in it than in the more compact part of bones, and are less liable to produce death.

Bones, like the soft parts, are subject to inflammation, and to its consequent symptoms—pain, increased vascularity, and tumor: but the progress of inflammation in them is slow. Its termination may be by resolution, in suppuration, or by mortification taking place.

Resolution, or the diminution of inflammation before it produces suppuration, ulceration, or death, takes place very slowly in bones; and they are generally left larger, heavier, and more compact, in consequence of
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an increased depofition of earth taking place during the inflammation, which it requires a confiderable length of time to remove.

Excepting in fcrophulous conftitutions, and under certain fpecific difeafes, fuppuration rarely takes place in bones from internal caufes : however, they are fufceptible of fuppuration ; and in cafes of local injury, where granulations are neceffary for the reftoration of the part, it always comes on ; but its progrefs is flow.

On account of the weak living powers and the proportionally fmall vafcularity of bones, mortification is more liable to take place in them than in foft parts. If a large blood-veffel going to a bone is divided, the anafamofing branches are feldom capable of continuing the circulation complete ; and as far as that ceafes the bone dies, and then exfoliates.

When

When a bone is fractured without a wound in the soft parts, as in what are termed simple fractures, adhesive inflammation takes place, after the same manner that it does in the soft parts, but the process is more slow. First a small quantity of blood is thrown out from the torn vessels, forming a tumor which fills up the space between the broken extremities of the bone: this blood retains its life: the red particles, and the serum are absorbed, and the coagulable lymph is left alone. In the mean time, the ossific matter is absorbed from the broken extremities of the bone, by which means the irregularities are removed, and they are rendered soft and flexible; their living powers are increased; and they appear more vascular, the vessels becoming enlarged, and probably branching off new ones. These vessels gradually elongate, and extend into the coagulable lymph until they meet, when they anastomose with each

each other : ossific matter is then deposited along their outsides, extending from the bones to the centre ; thus forming a substance which is called callus.

This callus is generally of larger diameter, and by consequence mechanically stronger than the adjacent bone. When the actions of life are in their healthy state, and not interrupted, the quantity of callus formed is in proportion to the distance which the extremities of the bone are from each other : if they are far asunder, the quantity of callus is large, forming sometimes a very considerable tumor ; if they are in contact, and well placed, the quantity of callus is very small, and the tumor scarcely perceptible.

At first the callus is more vascular than the original bone, but the deposit of earth goes on ; the vessels, after a certain time, are lessened in their diameters, some of them perhaps obliterated ; and it becomes less so :

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its living powers also are less. After a still longer time, it approaches in structure to the neighboring bone, becoming again somewhat more vascular. I have seen some bones that were fractured many years before death, in which I could distinguish little or no difference, either in structure or in vascularity, between the original bone and that formed after the fracture.

This is the mode of union which generally takes place in simple fractures, and sometimes in compound fractures also: it is by much the shortest, the safest, and the most desirable. If the limb is properly attended to, the pain, the trouble, and the time of confinement, are proportionally short, and it is attended with no danger to the system.

When this mode of union does not take place; as in most cases of compound fractures; and now and then in consequence of
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a very great injury, or of improper treatment, in simple fractures also; a very different process produces the re-union of the parts.

The coagulable lymph, which in the former case forms the medium of union, loses its life, or escapes. The inflammation increases to a greater degree, both in the bone and soft parts: sometimes it becomes so violent as to threaten destruction, not to the limb only, but to life. In the more favorable cases, after three or four days, suppuration appears extending over the whole of the wounded surface; generally attended with no small degree of pain, and with considerable fever. As the formation of pus becomes perfect, and the quantity of it increases, the inflammation abates; and the constitutional symptoms abate with it. Frequently for some days the pus is intermixed with what are called sloughs. These are generally supposed to

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be some of the organized parts that were killed by the mechanical violence which produced the fracture; but in the cases I now speak of, they are nothing else than portions of coagulable lymph that were thrown out during the first stage of the inflammation. The cavity which after a time is observed in the wound, is formed partly by the retraction of the surrounding living parts, and partly by the ulceration, or absorption of them.

In consequence of the destruction of some of the small arteries of the bone, a small portion of each of its broken extremities generally loses its life. Thus becoming an extraneous body, it acts as a stimulus to the absorbents of the living bone, with which it is in contact. These gradually remove as much of the living bone as forms the line of union, by which means the dead portion is separated. This process is called exfoliation;

exfoliation; and necessarily occupies some time. Whilst it is going on, a part of the bony matter is absorbed from the broken extremities, as in the case of simple fractures: then granulations form, and gradually extending from each extremity meet and unite, the vessels inosculating one with another.

These granulations are very similar in appearance to those formed by the soft parts; but they are smaller, more regular, slower in their progress, and rather paler than those of soft parts generally are: when examined they are found to be bony, excepting just on their surface. If in this state they are macerated, the eminences on the dried bone correspond exactly to those of the granulations when fresh. So that it seems the soft part of the bone is formed first; but the bony deposit very soon succeeds it, in regular progression.

The two portions of bone being thus united, the formation of bony granulations ceases; the part becomes less vascular; and the bony deposit continuing, it becomes also mechanically stronger. In the mean time, the granulations formed by the soft parts extend over those formed by the bone. The cicatrix then extending over them, the wound is healed.

The bony substance formed by granulations, like soft parts formed in a similar manner, possesses very weak living powers, and is very susceptible of diseased actions, as ulceration, &c.

I have now attempted a description of the method by which the living actions of the parts produce re-union, after compound fractures (strictly so called). Even in the most favorable cases it is very tedious, from the slowness of the process which unites the bones. I have represented it here, as occurring

ring in a favorable subject; and have stripped it of all those untoward circumstances, some of which are almost constantly met with in the course of the treatment.

C H A P. III.

OF COMPOUND FRACTURES, AND THE
TREATMENT OF THEM.

COMPOUND fractures happen to persons of different ages and constitutions; in health or in sickness: they occur in different parts of the extremities; and are produced by different degrees of violence. Two fractures therefore agreeing in all respects will very rarely be met with.

Sometimes the bone is broken in one place only, the integuments simply divided, and very little lacerated or bruised, as when produced by a blow with a sharp instrument. Sometimes the bone is broken
nearly

nearly transversely ; at other times more oblique. In the leg, or fore arm, if one bone only is fractured, the other will support the limb nearly in its proper form : I have seen a compound fracture of the tibia, in which the fibula kept the parts of the broken bone so perfectly in their situation, that the patient walked half a mile or more after the accident. Sometimes the soft parts are but slightly bruised, and considerably lacerated. Sometimes the laceration is inconsiderable, but they are violently bruised : this I have observed to be the case when a compound fracture is produced by violence applied to a bone superficially seated ; the integuments immediately covering the part were so bruised, that they died and sloughed away. Frequently the bone, or bones, are broken in different places. Sometimes the bone is much shattered, and the soft parts violently crushed, to a considerable extent. Often the fracture extends
through

through a joint ; and sometimes it is attended with an hæmorrhage from some considerable artery.

It is very seldom that a part suffers so much violence, as to be killed instantly. In the worst cases of compound fractures, the parts are generally left alive : but sometimes the violence which the soft parts suffer is so great that, although it may not destroy their living powers, it seems considerably to lessen them ; at the same time, it stimulates them to an inflamed action so violent that they are unable to support it, and mortification ensues.

The impossibility then of laying down rules, to regulate the peculiar treatment proper in particular cases of compound fracture, must be evident. The observations on this head must, in great measure, be general : the treatment of each particular case must be regulated according to its circumstances, by the judgment of the surgeon.

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SECTION I.

OF COMPOUND FRACTURES REQUIRING
IMMEDIATE AMPUTATION.

WHERE the whole of the soft parts surrounding one of the large bones are so much crushed, and torn, that their organization is nearly or wholly destroyed, while the bone is very much shattered through a considerable extent, there can be little doubt what ought to be done; amputation being the only means that can give the patient a chance for his life. For the limb in this case will certainly be lost; and the violent inflammation, and extensive mortification which will ensue, if it is not removed, will more endanger life than the shock from amputation, and the subsequent inflammation

tion in the stump. But the loss of a limb is not the only objection there is to amputation. When the patient is in full health, the whole system receives a shock which excites an amazing irritation, both in body and mind, under which it frequently sinks in a short time.

Amputation is not, properly speaking, a cure for compound fractures, but an apparently lesser evil, intended to remove an apparently greater one. The amputation of a limb is always attended with some danger, and when performed on persons who prior to the accident were in perfect health, as generally is the case in recent compound fractures, the danger attending it is very considerable. Therefore although I had no hopes of saving a limb, I would not amputate on that account merely, but wait till the violence of the inflammation is over; when the actions of life being weakened,
and

and the mind of the patient prepared, he stands a better chance of surviving the operation.

In amputation, the degree of danger to the life of the patient varies according to the size of the part which is removed, and according to the extent of the wounded surface formed by the stump. The removal of the upper extremity is attended with less danger than the removal of the lower. Amputation above the knee is attended with considerable danger; immediately below it with somewhat less. I have seen patients lost under both. When performed below the calf of the leg, the danger seems to be still less. Those amputations of the upper arm which have come to my knowledge have done well; though there has sometimes been considerable irritation and fever attending them. As far as my observation extends, amputation below the

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knee,

knee, or below the shoulder-joint, is not attended with any considerable danger to life, unless in very unfavorable subjects.

When the patient is so situated that every necessary attention can be paid to him, the only instances in which I conceive immediate amputation to be necessary are

In some cases of profuse hæmorrhage ;

And where the inflammation is likely to be extremely violent, and very extensive ; in consequence of an extensive laceration, and destruction of parts.

The division simply of a large artery, even of the principal artery of a limb, as of the brachial for instance, or of the femoral below the two vasti and the profundus, is not a sufficient reason for amputation ; as we may expose it by dissection, and pass a ligature round both ends of it. Experience proves that the anastomosis is sufficiently free to supply the limb with blood.

But

But sometimes when there is an extensive laceration of the soft parts, and a large artery deeply seated is divided, the inflammation ensuing the wound which must be made by the operation of passing the ligatures, added to the inflammation ensuing the accident, is too much for any constitution to bear.

Sometimes also, where there is an extensive laceration of the soft parts, several pretty large arterial branches are divided, which, on exposure to cold contract and cease to bleed, on their becoming warm the hæmorrhage breaks out afresh, but as soon as the surface of the wound is exposed the bleeding vessels again contract; by this means very often eluding our search; or after one vessel is stopped another breaks out. The hæmorrhage now and then continuing in this manner is so profuse in a short time, that the patient is very much sunk from loss of blood. Patients in these
cases

cases require very close attention ; and if repeated endeavors to discover and secure the vessel should fail, the operation ought not to be delayed too long ; for sometimes, in a few hours, the inflammation and consequent fever becomes so great, that if amputation is performed then it almost infallibly destroys the patient.

When the laceration and destruction of parts is very extensive, or extending into a large joint, amputation is generally proper : as in some cases we can remove an extensive wounded surface, on which such a violent inflammation would succeed that the system cannot possibly support it, and substitute in its place a smaller surface of wound, and a less violent and less extensive inflammation, which there may be a chance of the system supporting. There is so much difference in the strength and irritability of different people, that it is impossible to say, *à priori*, without some uncertainty,

tainty, what degree or quantity of inflammation any particular person can support, or even what degree or quantity of inflammation will actually come on. Very bad compound fractures, passing through joints, and exposing an extensive surface of wound, have in some cases done well; while in other cases, which seemed trifling compared with the former, the patients have sunk: nay many sink under amputation which is proposed here as a palliative. In general, those people who are given to excesses are the most unfavorable. Next, those who are remarkably strong and robust, of the athletic or sanguine temperament. While those who live temperate, are less robust, and approach to that state of constitution called the phlegmatic temperament, are subjects of a more favorable prognosis.

Generally speaking, it seems to be the best practice to amputate,

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1. In cases where a compound fracture extends through a large joint if either bone is shattered; if both bones are fractured ; or if the ligaments, and surrounding parts are so bruised, or lacerated, as not to afford a tolerable prospect of its healing by adhesive inflammation. Thus if the extremities of the tibia and femur are both crushed, there is very little likelihood of the limb being restored ; such a violent inflammation would ensue as, it is most probable, would destroy the patient ; and he stands a better chance for his life if the limb be amputated. But if the fracture passes through the extremity of one bone only, which at the same time is not crushed, nor the surrounding parts much bruised nor extensively torn, there is a great chance of the soft parts healing by adhesive inflammation. If this should fail, the means employed in attempting it tend to retard the inflammation ; and with proper attention
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the patient's life stands, in my opinion, as good a chance as after amputation. When the first symptoms are abated, there is a great probability of a cure by granulations ; and should the formation of pus become so excessive as to endanger life, amputation may then be performed with a much better chance of success.

In the elbow-joint, the surface being much less than in the former, there is not that danger to the system from inflammation extending over it ; hence it will bear a much greater injury without rendering immediate amputation necessary. But if the bones are much crushed, as is often the case, from a loaded waggon passing over the arm, or from an heavy body falling on it when it is resisted on the other side ; as there is little chance of rendering the limb useful, and as the subsequent inflammation would expose the patient to much greater danger than

G amputation

amputation would, it is the safest practice to amputate immediately.

In the ankle-joint the quantity of surface is less than in the knee, and greater than in the elbow. It is surrounded by a number of tendons: these when inflamed induce considerable constitutional sympathy, and their living powers being but weak, they do not granulate very favorably. When this joint is so crushed as to produce a compound fracture, the surrounding parts will generally be bruised and torn to a great degree; and then the safest practice is to amputate immediately.

In compound fractures extending into the joints of the tarsus, or carpus, or any of the smaller joints, unless several of them were involved in the accident and there appeared no possibility of saving the part, I should not amputate immediately.

2. In cases also where the bone is shattered to a considerable extent; especially if,
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as is then generally the case, the soft parts are much crushed and lacerated. For in all probability so extensive an inflammation, and perhaps mortification, will ensue, that the system cannot support it.

3. In some cases also, where the mischief to the bone and soft parts is not quite so great as in those above-mentioned, if a principal artery of the limb be divided. For though neither the division of the vessel, the laceration, nor the fracture may singly justify the removal of the limb, yet the whole together will frequently render it necessary.

In a compound fracture of the thigh, with a division of the femoral artery, provided the patient be not lost from the hæmorrhage before assistance is obtained, it would generally be a rash practice to attempt the saving of the limb. For the laceration of a very considerable portion of soft parts

must take place, to produce a compound fracture and divide the artery at this part. The dissecting down such a depth, as is necessary in order to expose the artery and apply ligatures round both ends of it, will very much increase the surface of the wound and the consequent inflammation: so many of the anastomosing branches will be divided as greatly to lessen the chance of the limb being supplied with the necessary quantity of blood; and the whole will give such a shock to the system, that it will be a miracle if the patient survives.

In compound fractures of the upper arm with a division or rupture of the brachial artery, if the parts are considerably torn, or crushed, it is safer to amputate: but when the bone is broken in one place only, and but a small portion of the soft parts are lacerated, we may attempt to save the limb. The artery, as it extends along the
inner

inner edge of the biceps muscle, is easily come at; and the surface of wound necessarily made for the application of the ligatures, is by no means considerable. There are two or three large branches given off from the brachial artery, just below the insertion of the teres major muscle, which communicate with others given off from the same artery, about the shoulder and elbow joints, and also with branches from the ulnar and radial arteries; so that the communication of vessels seems much freer in the arm than in the thigh, while the parts to be supplied with blood are much smaller.

A compound fracture of the tibia with a division of the posterior tibial artery, will generally be attended with the loss of the limb. The danger is not from the want of a free circulation below it; but being covered through the greater part of its length by the gastrocnemii muscles, it is so deeply seated

feated that it is almost impossible to get at it to make ligatures on it. Should the surgeon succeed, the length of the operation, and the extent of the wound must be such, as, together with the fracture, much more to endanger the life of the patient than amputation would; nay, in all probability, to destroy him. But if this vessel be ruptured below the gastrocnemii muscles as it passes towards the inner ankle, it may be come at without any great difficulty; so that it is unnecessary to amputate merely on account of the hæmorrhage.

If the anterior tibial artery be divided anywhere beyond the distance of about an inch from its origin, the difficulty or danger that attends making a ligature on it is but trifling, and ought to have very little weight in determining for amputation.

A division or rupture of the interosseal artery is a disagreeable circumstance. For
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although it is smaller than either of the former, the hæmorrhage from it is likely to be very troublesome. It is very deeply seated, and from its smallness difficult to find; and will I am apprehensive often render amputation necessary: though I have seen it very small in some subjects; and in that case, if the division be pretty low down and quite through, it would most probably stop spontaneously. I have seen some cases of compound fracture in which the hæmorrhage was not profuse, and in a little time ceased; and upon the limb becoming warm, or in consequence of one of those convulsive motions which so frequently attend this kind of accidents, the hæmorrhage returned; on the limb being exposed, it stopped again; and in the course of that or the succeeding day again returned. This continued for ten days, or a fortnight; when the patient was so reduced, that amputation became necessary

cessary to save life. By the apparent seat of the vessel from which the hæmorrhage ensued, I was led more than once to think that it was the interosseal artery which had been wounded.

In the fore-arm the ulnar artery, in passing under the flexor secundi internodii pollicis, is situated pretty deeply; but below this, should it be divided, it may be come at with little difficulty.

The radial artery is superficially situated throughout its whole length.

In making ligatures upon either of the last-named arteries towards the wrist, care should be taken not to include any of the surrounding tendons. If this caution be neglected, a considerable inflammation is unnecessarily induced, which greatly adds to the patient's danger.

There are, generally, two considerable branches of arteries called interosseal, which

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at the upper part of the fore-arm are very deeply seated. These if lacerated are difficult to find; and if the hæmorrhage continued so profuse as to reduce the patient to a state of danger, might render amputation necessary. But the arm becoming smaller as they advance lower down, they are situated nearer the surface. Here an attempt may, and ought to be made, to pass ligatures on them, unless other circumstances indicate amputation.

4. Compound fractures sometimes occur in which the violence done to the parts is far from being considerable, that are attended with an hæmorrhage, which has nearly ceased by the time the surgeon is called in. When the limb is dressed and becomes warm it breaks out afresh; but on exposing the wound to the air, it again ceases; and on its being dressed up, again breaks out; thus eluding every method that is taken to stop it, or to discover the wounded vessels.

Cases of this description are extremely unpleasant, and require the utmost attention. Sometimes a moderate pressure being made on the part where the bleeding vessel is supposed to lie, may answer the end. Sometimes a gentle pressure round the limb is more effectual: but this mode requires great care; and when the inflammation comes on, the patient is seldom able to bear it. The application of spirits of wine, or what is a still more powerful styptic, spirits of turpentine; may be tried; but the latter must be used with caution, as it increases the inflammation. If the hæmorrhage is profuse, care must be taken not to delay amputation too long; for if it be not performed before the inflammation comes on and the symptoms of irritation take place, there is little chance of its saving life. I have seen a patient sink under the hæmorrhage in this case.

Some

Some cases of simple fractures of the tibia are upon record, where a slow but continued hæmorrhage produced such an amazing distention of the limb, that it was thought proper to amputate. It was found on dissection, that the bone was fractured just at the entrance of the medullary artery, which by consequence was torn through, and from the firmness of its adhesion with the surrounding parts was incapable of contracting. Should a similar accident occur in a compound fracture of this bone, and the surgeon be aware of it, there can be no great difficulty in stopping the hæmorrhage. A small instrument passed into the hole will separate the vessel sufficiently to allow of its contracting; and if the hæmorrhage still continues, its sides may be pressed together by a small plug.

SECTION II.

OF UNION BY ADHESIVE INFLAMMATION.

SUPPOSING that none of those circumstances occur which render immediate amputation necessary; our object is, if possible, to save the limb, and to restore it to its former state and functions. To effect this object, the general indication seems to be,

To procure a re-union of the divided parts with as little inflammation, with as little deformity, and as speedily as possible.

I have observed that there are two modes by which union takes place in compound fractures. Of these, that by adhesive inflammation is undoubtedly best adapted, in every possible respect, to the above indication: and could we always be so fortunate

nate as to succeed in conducting the living actions of the part to this mode of cure, it would be unnecessary to mention any other. Instances of union by adhesive inflammation in compound fractures are very rare ; so rare that the generality of surgeons hardly ever think of attempting to procure it. Indeed it appears to me to be too much neglected. By attempting oftener, I am of opinion that much of the danger, pain, and confinement which generally attend compound fractures, may sometimes be avoided. And even should it fail, as it will more or less in many instances, the treatment which ought to be followed in attempting it is that which is most proper to lessen the subsequent inflammation, to prevent an excessive discharge of of pus, and to forward the cure by granulations.

I have observed that in compound fractures the injury done to a part is very seldom so great as to cut off the circulation,
or

or immediately to kill it; that mortification, when it occurs, is generally the consequence of violent inflammation. If this observation be true, then by lessening the inflammation, we lessen, or even entirely prevent the mortification. The danger then of mortification taking place from excessive inflammation, does not prevent the attempting of this mode of cure. For the most certain way of preventing the increase of the inflammation is, to procure an union between the divided surfaces. Where there is a loss of substance, and so great too that the parts cannot all be brought into contact, attempts may be made to procure adhesive union between the parts contiguous to the bone, to bring that, if possible, into the state of a simple fracture. Should we fail in the attempt, still it is proper to procure adhesive union as far as possible, by bringing as much of the surface of the wound into close contact as the situation of the parts will permit.

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In every case of compound fracture therefore, I would endeavor to unite the whole of the wound, or as much of it as is possible, by adhesive inflammation.

In order to render this mode of treatment as certain, and as effectual as possible, the following appear to be the principal indications.

1. To stop the hæmorrhage.
2. To reduce the bones to their proper situation.
3. To bring every part of the wounded surface into close contact with its opposite surface.
4. To retain both the bones and soft parts in their proper situation, till they are united.
5. To moderate the violence of the inflammation.

§ 1. The first thing that commands our attention, in compound fractures, is the hæmorrhage.

hæmorrhage. If profuse, a tourniquet should be applied, till the ruptured vessel can be secured. In the present case, particular attention is requisite, that the hæmorrhage does not continue, nor return after the parts have been brought together ; otherwise the blood collecting and coagulating in the wound, will separate its sides, and frustrate our intention. This is a cause which very frequently prevents adhesive union taking place ; therefore it cannot be too much attended to. Any vessel that may be observed, from which we fear an hæmorrhage returning on the parts becoming warm, should be secured by a ligature. This ligature should include no more of the surrounding parts, than cannot possibly be avoided. The smaller vessels will be prevented bleeding, by bringing the surface of the wound together : if this is not sufficient, a very gentle pressure may be made

made, but with great caution, by the bandage.

§ II. The patient being placed upon a bed, and a proper support (of which I shall speak hereafter) being provided for the limb, the extremities of the broken bone should be placed as nearly as possible in their natural situation. What other practitioners may have met with, I cannot say; but in those cases which I have met with, very little difficulty has occurred in this part of the operation. I have seen the superior portion of a fractured tibia protrude so much, that it was proposed to remove a considerable portion of it; but on relaxing pretty equally the muscles of the limb, it was reduced to its proper situation with great ease. The limb then should be placed in such a state, that all its muscles may be relaxed as much as possible. The inferior portion should be

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extended, when extension is found necessary, in a very slow, gradual manner ; and then reduced to its natural situation. If, from the smallness of the external part of the orifice, the skin should bind the bone too tight to admit of its being freely reduced ; on examining the skin round the edge a part will generally be found which is rather hollow, from the soft parts beneath being lacerated beyond it ; by dividing this the size of the opening may be sufficiently increased. I very much doubt if ever it is necessary to remove a portion of the bone, in order to effect its reduction ; but when the bone is protruded, if the fracture is very oblique, and a portion near the extremity is so denuded that it is more than probable an exfoliation must ensue, it is better, if it can be done conveniently, to remove that portion. In doing it, the greatest care is necessary to keep the bone well supported, that

that it may not be jarred by the saw; and that no violence be done to the limb. If there be any spiculæ at the ends of the bone which are likely to prick or irritate the soft parts, these may be removed with a pair of forceps.

The bone being reduced, examination should be made with a finger, if it can be introduced without violence, whether there can be any loose portions of bone so far detached as to render it probable that the circulation through them is cut off; for such portions when they can be come at ought to be removed. Otherwise, if they die, a constant irritation is kept up, and a troublesome abscess formed by the presence of an extraneous body.

§ III. Having reduced the bones to their natural situation, the next indication is to bring, if possible, all the wounded surface of

the soft parts, into contact. What! bring the sides of a lacerated wound into contact with an intention of uniting them, before the sloughs have separated, or before the inflammation is reduced by a plentiful suppuration? Even so. We know that bad, lacerated wounds, even when connected with a fracture, do occasionally heal, if they are so situated that the parts happen to fall in contact spontaneously. The case which happened to Mr. Pott himself, is a sufficient proof of this. The parts falling accidentally in contact, and uniting during the adhesive stage of the inflammation, was, in my humble opinion, the reason of this case proving so favorable, and not, as was supposed, the exclusion of air merely—that was a necessary consequence. If adhesive inflammation sometimes takes place unexpectedly, where torn parts are by accident brought into contact, why should not we endeavor, in every case, to avail ourselves of it?

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The principal objections that I have heard against this practice are,

That the inflammation is frequently so violent as to endanger mortification; and that to abate it we ought to induce an early and a plentiful suppuration.

That some portion of the soft parts are generally so injured in their structure as to be incapable of union, until a part of them has sloughed off; and that the wound ought to be left open for it to separate.

That there is danger of confining or locking up (as it is called) the matter.

To the first of these objections I beg leave to answer, that the best, and the most certain means to prevent the inflammation becoming too violent, is to procure an union between the sides of the wound, in the first stage of it. If union takes place, the stimulus is removed, the inflammation subsides, and the parts resume their healthy actions.

Attempting

Attempting it does not prevent the use of remedies to abate the inflammation ; on the contrary, it co-operates with them, and ought always to be accompanied by them : for if the inflamed action hurries on too rapidly, it gets past the adhesive inflammation, before union has taken place. It appears to me in the next place, that it is the mistaking of an effect for a cause that leads to this manner of reasoning ; that it is not suppuration, but the cause of that suppuration—to wit, the reducing of the inflammation to a certain standard, which prevents mortification taking place. For in those cases of compound fracture where immediate amputation is thought unnecessary, it seems to arise generally in consequence of the inflamed action being too violent for the parts to support ; and seldom from the powers of life being so lessened that they cannot support a moderate inflammation.

Now

Now suppuration cannot take place when the inflammation is so violent as to kill the parts. Consequently, if we can induce suppuration; or, more properly speaking, if we can keep down the inflammation to that point at which suppuration is produced, we effect a very desirable object. By the same reasoning, if we can induce union by adhesive inflammation; in other words, if we can keep the inflammation down to that point at which union by coagulable lymph is produced, we effect an object still more desirable; neither mortification, nor suppuration can take place, and neither are necessary.

When the inflammation has gone past the adhesive stage, and suppuration is produced, the discharge of pus which comes on seems to moderate the inflammation. But it must be remembered, that before any advantage is derived from this discharge, suppuration has come on, and then the danger from mortification is generally over.

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With respect to the second objection ; when the structure of a part is so destroyed that the circulation through it is cut off, it loses its life, consequently becomes incapable of any action depending on life ; then it is absurd to think of uniting it with the surrounding parts : it becomes an extraneous body, and acting as a stimulus, excites an inflamed and ulcerative action in them, and makes room for its removal. But in cases where some doubt is left whether the circulation is, or is not, so far cut off from a part that it must die, and it is not judged proper to remove it, the most certain way to prevent its death is to attempt the uniting of it by adhesive inflammation ; and should the attempt fail, no harm can ensue.

As to confining the matter, it should be recollected that matter must first be formed. Therefore, if the adhesive union succeeds fully, there is no great danger of confining
matter :

matter: if the union be partial, as soon as matter is found collecting, it ought to be let out by a free opening, made in that part which is most favorable for its free exit in future. By this means we often derive considerable advantage, even where the attempt partly fails; at the same time that the quantity of inflammation is lessened.

Before the parts are brought together, the most minute attention ought to be paid to the removal of extraneous matter, coagulums, or any hæmorrhage by which coagulums may be formed; as these, by preventing the parts coming in contact, will frustrate our intention.

To retain the soft parts in contact, different means may be employed. Slips of adhesive plaister are best, when they answer the purpose; as they irritate less than any other method. They should be of such a length as to retain the parts without being

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in danger of flipping, but should not extend too far round the limb; for if much swelling should come on, they will be liable to act as ligatures, confining and irritating the part, and retarding the return of the venous blood. They ought, also, so to be applied that they may be removed, when necessary, without moving the limb. These may very advantageously be assisted by a relaxed position of the wounded part; also, by the application of a many-tailed bandage moderately tight, but not so tight as to give pain. The bandage, by its pressure, not only supports the sides of the wound, but brings the inferior parts of it into closer contact than they would otherwise be brought. At the same time great attention is requisite not to apply it too tight; for then, by the irritation it produces, it will increase the inflammation, and thus probably frustrate its intention.

Sometimes

Sometimes the retraction of the divided parts is so forcible, and the depth of the wound so great, that the above means are not sufficient to retain the sides of it in contact. In these instances, I recommend the passing of one, or more ligatures. I do not recommend the use of ligatures, if the parts can be brought into contact, and retained so without them; for some inflammation is excited by passing them, and still more by the unequal pressure which they make. But where we have reason to hope for the advantage of adhesive union, and the parts cannot be retained in close contact by other methods, this should on no account be omitted; and it should be assisted as much as is possible, by the other means above mentioned.

In bringing the parts together, whatever means are used, a very nice attention ought to be paid, that every part of the surface of

the wound be brought into contact with its corresponding part; for it is not sufficient that the integuments merely are brought together. I have met with several deep-seated lacerated wounds, where a sufficient attention not having been paid to this point the external part united readily; but the internal part did not unite, and a troublesome abscess formed. This is a point of so much consequence to the success of the plan of treatment here adopted, that I think it cannot be too much dwelt upon.

§ IV. Having thus brought the parts in contact, and applied some soft, mild application, to prevent the edges of the wound being irritated by the bandage; the next consideration is, how to retain the limb perfectly still, and in its natural situation, till bony union is formed. For this purpose, various means have been recommended;
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all of which may probably be referred to, Position: and the application of external means, to support, and confine the limb; as bandages, splints, &c.

1. In placing the limb, there seems to be two objects of consideration; the ease of the patient, and the relaxing of the muscles.

The body of the patient ought, if possible, to be placed in that situation which is easiest, in which all the muscles are most relaxed, and where the surface of contact on which he rests is broadest; for in that position he will be able to continue longest without moving, and will be less liable to move inadvertently. It can require no other argument to prove how necessary it is that the body should be kept in one posture during the cure, than to observe that it cannot admit of the least motion without moving the limb in some degree. Therefore lying in an horizontal posture, on the
back,

back, upon a mattress, with the head, but not the shoulders, a little raised, will generally be found the best position. If the shoulders be raised, even but a slight degree, the patient will be perpetually slipping towards the foot of the bed, which is always disagreeable, and often very troublesome. In fractures of the leg and thigh, it has lately become a very general practice in this kingdom, to lay the patient on his side, that the limb may be placed in a relaxed position. But in most cases which I have seen, this position soon became tiresome; and neither the patient, nor the limb, continued long in the state they were first placed in. The patient generally turns upon his back, with the knee almost straitened; or else, the thigh being turned out, the adductor muscles are so much extended that the knee is perpetually being raised from the pillow, which keeps the fractured ends of
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the bone continually in motion. So that in fractures of the leg, the weight of the knee, and upper part of the limb, is in great measure supported upon the lower extremity of the superior portion of the fractured bone: this, by its pressure on the soft parts is continually irritating them, and increasing the inflammation in them. In fractures of the thigh, the weight of the leg will draw the knee downwards; the tense state of the adductor muscles will in many instances draw the fractured extremities of the bone inwards. Thus there is danger of the fracture uniting in an oblique direction. Or, when the upper portion of bone does not support the lower, whether from their extremities not being in a line, or from the obliquity of the fracture, the end of the lower portion will be drawn over that of the upper, and then the limb will be shortened.

Many

Many practitioners, in fractures of the leg and thigh, still continue to lay the patients on their back, with the limb extended. And indeed I cannot say that I have observed those ill effects, from this position, which are spoken of by those who are advocates for the leg and thigh being laid in a bent position, on its side. I have seen cases treated in both ways, where the patients have recovered with very little deformity; and I have seen cases of fractured thighs treated in both ways, where the limb has been shortened. And when a thigh that is fractured low down is laid on its side, if great attention be not paid to keep the knee properly supported, the bones are very liable, as I before observed, to unite at an angle.

I must not, however, be misunderstood as favoring the extended position of the limb; there are, certainly, considerable inconveniences

niences occasionally attending it. A number of muscles are kept constantly extended; and the limb is very apt to be shortened, by the ends of the bone being drawn over each other. In fractures of the tibia, I have seen the gastrocnemii muscles draw the inferior portion of the bone so much backwards, that the extremity of the superior portion has projected very considerably; and, exciting ulceration through the skin, has produced a sort of compound fracture. This however is not a frequent occurrence.

In a fracture of the leg or thigh, have sometimes observed, that if the patient is placed on his back, with the limb extended, it for some days feels uneasy, and there is a tendency to draw it up; but if he is at first placed on his side, with the limb in a bent position, and it continues so for a few days until the inflammation is somewhat abated, and then he gets round upon his back, with

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the limb strait, as is often the case, he seems much relieved, and the cure of the limb goes on as well as, or better than before : for as the inflammation abates, the muscles are less liable to be stimulated to contraction by extending the limb ; and after the limb has been confined some time, the loss of motion lessening the actions which are going on for the support of it, the muscles gradually become weaker and less susceptible of contraction, and seem to lose in some measure the habit of contracting.

But I do not recommend this practice. Because in most cases it is not necessary for the patient to lie on his side at all, nor to keep the limb at all in an extended position ; and because it is improper to move the limb during the cure.

When the situation of the wound does not prevent it, the patient in my humble opinion ought in general to be laid on his back ;
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and by raising the limb and properly supporting it the muscles may be relaxed, as far as the flexion of the limb will admit of it. In fractures of the thigh, great care should be taken to keep it equally supported through the whole of its length: also the knee and leg should be properly supported, that the weight of them may not draw down the lower end of the femur; and in general it is better to keep the leg in an horizontal position, that the extensor muscles may not be too much stretched. In fractures of the tibia, the leg should always be in an horizontal position; and some compresses ought to be put under the small of the leg, to prevent it resting too much upon the heel. The limb may be supported either upon thick pillows, or upon a frame, which is better, being less liable to slip or yield. For fractures of the leg, a frame invented by a Mr. Rae, and delineated in

plate 73 of Mr. Bell's Surgery, seems very well adapted; more especially if the wound be at the inferior part of the limb. But if such a frame is used, the thigh should be supported by a pillow or two. In placing the limb, after a compound fracture, attention must be paid to the situation of the wound; for that must, if possible, be so situated that it may be come at, whenever it is necessary, without moving the limb.

When a fracture extends through a joint, the limb ought to be placed in that position in which it is most likely to be useful, in case an anchylosis should form; as will generally be the case if it is saved. Thus, in a compound fracture extending into the knee-joint, if it is thought proper to attempt to save the limb, it ought to be placed in an extended position; for if an anchylosis forms with it bent, the leg will ever after be useless. I remember
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one case of this kind, where the patient was desirous of having the leg amputated, on account of the inconvenience he suffered from its being always in his way. But an anchylosed leg, when strait, is infinitely better than an artificial one.

In a compound fracture extending into the elbow-joint, the arm should be bent to about a right angle; which is generally the most convenient position.

If from any particular reason the parts cannot be placed in this situation immediately after the accident, they should gradually be reduced to it as soon as possible after the inflammation abates.

Now that I am speaking on the subject of fractures extending through joints, I will beg leave to observe, that in case the soft parts unite by adhesive inflammation, there remains a possibility of still preserving the motion of the joint. For this purpose, after the inflammatory

flammatory symptoms are gone off, and ossific matter is forming between the portions of bone, attempts should be made to bend and extend the joint a little, daily, taking care not to excite too much inflammation; and any inflammation that may arise, should be suffered entirely to subside before the limb is moved again.

2. Having placed the limb properly, the next thing to be considered is, how to keep it in that situation during the cure. For this purpose, bandages, splints, junks, &c. are generally used.

Of the two former there are great varieties; some of which answer their purposes tolerably well; others very indifferently. To point out their advantages, and disadvantages, it will be proper to consider their uses, and what we are to expect from them.

To keep a fractured limb in its proper situation, the motion to be avoided may be considered under two heads:

That

That which alters the situation of the whole limb; and

That which alters the situation of the fractured portions of bone, with respect to each other.

Bandages, and splints, will have very little effect, in preventing the first species of motion: the prevention of it must depend on the limb and body having a firm support; and upon the attention of the patient to keep both unmoved. All that can be expected then from bandages and splints, is to keep the different parts of the limb in a proper situation with respect to each other.

The bandage generally used in compound fractures, is what is called the many-tailed bandage: indeed any other kind of bandage with which I am acquainted is extremely improper, on account of the necessity there would be of moving the limb every time the wound is examined. The best material to make it of, is
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some very fine welch flannel ; as this is more elastic than any other material we are acquainted with, it better admits of an equal pressure being applied to the limb, and more readily yields to a moderate distention. The pieces, of which it is composed, may be fastened together as is generally done, or they may be separated for the convenience of removing some of them, when necessary : for the removal of the pieces singly, will disturb the limb much less than the removal of the whole bandage at once. Great attention ought to be paid, to apply the bandage in such a manner that it may press equally. It should be applied sufficiently tight to support the parts, and gently to press them together ; but not so tight as to obstruct the circulation, or to give pain ; for then it increases the inflammation, and does harm. The moment it is noticed that the tumefaction of the limb increases so much
that

that the bandage gives pain, or interrupts the freedom of the circulation by its pressure, it must be loosened.

What is principally to be expected from a bandage, is gently to press the wounded parts together, and support them ; by that means assisting to keep them in contact. It also confines, to a certain degree, the broken ends of the bone, and prevents them from moving so freely as they otherwise would.

But a bandage alone is very inadequate to the supporting of the whole limb in its natural position : therefore, after applying the bandage, recourse is had to splints, junks, and other contrivances.

Splints, when well constructed, appear to be the most proper to keep the limb steady. They ought to be of such a length as to confine the joint at each end of the bone ; and, if practicable, the whole of the limb below the fracture ; to prevent as much as possible the

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action of any of the muscles, or the least motion of the limb.

I observe not without some concern, that notwithstanding what has been said on the subject of splints by different people, more especially by a late respectable author, and notwithstanding the testimony of general experience is against them, short splints still continue to be used, even in compound fractures, by many people whose practice is pretty extensive. That people sometimes do well under their use, is undoubted; and so may a person in a miliary fever, whose bowels are constipated, and whose skin is covered with a profuse sweat from the action of pulvis sudorificus, a hot room, and thick blankets: but the recovery in this case is no proof of the propriety of the treatment. Short splints are improper, in every case of fracture; and particularly so in compound fractures: they are incapable

pable of preventing the motion of the limb, or of confining the fractured bone in its proper situation ; and by their pressure they increase that inflammation which is already too violent, and which requires the utmost attention to moderate it.

As short splints do harm by their pressure exciting inflammation, so it is necessary to be particularly careful in applying long splints, that no pressure be made on the fractured part : it will be of no service towards confining the limb, and may do great mischief by unnecessarily increasing the inflammation. It is a good practice to line the splints with fine wool : but I have sometimes observed an improper manner of doing it ; which is, to apply the wool thicker in the middle, especially over the wound, and thinner at each end. The contrary practice to this ought to be followed ; by which means the sound part of the limb

and the joints will have the pressure more equally applied to them, while at the fractured parts the splints will be a greater distance asunder, and consequently the pressure on them will be removed.

The splints may be made of different materials. Those made of wood, if they fit the limb and are sufficiently excavated about the part applied to the fracture, are certainly the best. Paper splints, being sufficiently firm, would answer the purpose as well; but when there is a discharge from the wound, it is liable to be absorbed by them: they then become soft, and smell very offensive. Where the surface of the limb is pretty even, as in the thigh, strips of wood fastened together by leather or packthread, make very good splints: but in fractures of the leg, the surface of the limb being very uneven, there is less risk of pressure being applied improperly when splints made of whalebone

whalebone are used, provided firm wooden splints that fit the limb cannot be procured. To the inequalities on the surface of the limb should be adapted corresponding inequalities on the lining of the splints, remembering at the same time to leave the fractured parts as free from pressure as possible. When the limb is laid on a splint, the lining should be made to support the limb equally in every part; otherwise the fractured extremities of the bone may be inclined downwards, and unite at an angle. But the upper splint, or splints, should be so lined as to press very lightly on the fracture.

Some people who are prejudiced in favor of short splints, finding them incapable of retaining the limb in its proper situation and often doing mischief by their pressure, have been led to assist them by applying junks over them; and others, observing that

mischief

mischief is sometimes done by the improper pressure of long splints, prefer junks even to them.

With respect to the former treatment, short splints ought never to be used, whether junks are or are not applied. With respect to the latter, improper pressure may generally be avoided by properly lining or padding the splints. So that junks on this account are very seldom necessary; and as they do not confine the limb so securely as long splints do, I think there are few cases in which they are so proper.

If from the restlessness of the patient, or from convulsive actions of the muscles, the means above laid down are not capable of keeping the limb in its proper situation, a person should sit constantly by the patient, to secure it until these unpleasant symptoms have ceased.

§ v. The limb being secured in a proper situation, and in such a manner that it may be examined when necessary without moving it, we are next to attend to the succeeding inflammation. This must be moderated by every means in our power: for a very moderate degree of inflammation is sufficient to produce adhesive union; and if the inflammation should be too great, this mode of cure will fail.

In the more favorable cases, some sedative or discutient application may be applied to the limb. A diluted solution of acetum lithargi, with a small quantity of spir. vini added to it; or the ammonia muriata, are as good applications as any. The bandages may be kept constantly moist with one of these, or some similar application; and the wound, to prevent its being irritated, may be covered with some mild ointment.

If after this the parts should become very tumid and painful, the splints should
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be removed and the bandage opened ; and a person being placed to guard the limb from the least motion, several leeches should be applied as near the edges of the wound as the plaisters will admit of: these should be repeated in the course of twelve or twenty-four hours, if there is occasion. Tepid vapour may then be applied by means of fomenting flannels, wrung out in warm water or a decoction of poppy-heads ; but in doing this, care must be taken not to move the limb, nor to irritate the edges of the wound. If the inflammation still continues to increase, a poultice may then be applied. It is a soft, relaxing application, and a good means of regulating the temperature of the part : it may also be made the vehicle of any sedative application. The poultices should be applied, and removed, without stirring the limb. For this reason they had better be applied with a spoon, and removed again with a spoon, or spatula ;

spatula; for if the limb be the least moved, that motion will increase the inflammation more than the poultice can diminish it. When we have reason to think that a poultice, or leeches, may become necessary, it is a good practice to have two bandages applied under the limb, with a piece of oiled cloth between them, and two or three bits of rag laid over it. By this means the lower bandage will be kept clean for future use; the rags will be of service to confine the poultice, and may be withdrawn one by one as they become dirty.

When a poultice is applied it is impossible that splints can be of much service in securing the limb; and here I think I have observed junks to have the advantage. But if they are not applied at the time the limb is reduced, it ought by no means to be moved to apply them afterwards. In either case the limb ought not to be left; but a

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person

person should constantly attend to watch it; who, that his attention may not be taken off from it, should have hold of the joint next above the fracture. By a strict attention to these circumstances I can from experience say, that poultices may frequently be used with advantage in compound fractures.

It may perhaps be objected, that poultices induce suppuration, whereas suppuration is what we are here endeavoring to avoid.

It appears to me that poultices, by keeping the surface of the parts to which they are applied moderately warm and moist, act as relaxants to the superficial vessels; by which means their susceptibility to action is diminished. The same effect is produced in the deeper-seated vessels, from their sympathizing with the former. By thus relaxing the vessels we render them less susceptible of the inflamed action; and by that means lessen the inflammation. The producing

ducing of suppuration is not merely the effect of relaxing the vessels, but of certain laws of the animal economy. For when the inflammation is sufficiently kept under, whether by poultices or by any other means, if the parts are alive and the surfaces in contact, they will unite before suppuration can take place; and when they have united, the stimulus which kept up the inflammation having ceased, the inflamed action will cease also, and the natural actions return: whereas if the inflammation is not sufficiently kept under, or if the living parts are not in contact, adhesive union cannot take place; the inflamed action goes through the adhesive inflammation, and altering the structure of the surfaces, produces pus.

Poultices may be rendered more effectual by the addition of emollients, and sedatives; but in the use of the latter, some discretion is necessary. Cold is perhaps the most pow-

erful sedative that can be applied in the form of a poultice ; but I by no means approve of its application in compound fractures ; for cold, at the same time that it lessens the actions, lessens the living powers of a part. But in compound fractures, while we attempt to lessen the actions, we ought to use every means to increase the living powers ; for in general they are lessened by the violence of the injury, and sometimes to such a degree, that there is danger of mortification from that cause alone, and should we lessen them still further, that danger must be increased : besides, to produce a sedative effect, the application of cold should be continued for a considerable time. But poultices soon take on the temperature of the limb : therefore it would be necessary for them to be repeated frequently ; and this is disagreeable.

Poultices should never be so large as to irritate by their weight ; nor should they
be

be continued on the limb so long as to become stiff and dry. They should, in general, be repeated about once in eight or twelve hours. In applying, and removing them, great care should be taken not to irritate the limb, nor to remove any of the slips of plaister which are applied to keep the sides of the wound in contact.

If there should be considerable symptomatic fever, with a hot, dry skin, and a quick, full pulse, blood should be taken from the arm. But in general as the fever is in proportion to the inflammation in the limb, three or four ounces of blood obtained from that part, by means of leeches, will do more good than sixteen ounces taken from the system, and will weaken the patient much less.

The surface of the body may be relaxed, and the hardness of the pulse lessened, by small doses of some antimonial preparation. But vomiting ought to be avoided. If the
bowels

bowels should be too open, small doses of opium may be given with the antimony.

The bowels should be kept laxative; but strong purgatives are improper.

The pain and spasm which are usually felt, are best allayed by opium.

The diet should be such as is easy to digest, such as affords but little nourishment in proportion to its bulk, and is perfectly free from any stimulating quality. It should at first be wholly vegetable; even new milk, unless much diluted, ought to be avoided. The acescent fruits, as oranges, currants, apples, &c. are proper; but those of a higher flavor, as pines, melons, and most preserves, ought to be avoided; for they are hard to digest, and by their presence in the stomach are apt to induce nausea and sickness, to prevent the digestion of food, and I have seen them produce considerable irritation in the system.

Condiments should be avoided.

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The drink should be weak, without the least proportion of spirit. Therefore all wines, and malt liquors, are improper. In their stead, toast-and-water, barley-water, infusion of balm, and of other mild grateful herbs, should be substituted.

How long this plan ought to be persevered in must be left to the surgeon to determine, who is to be regulated by the strength of the patient, and the state of the inflammation.

SECTION III.

OF UNION BY GRANULATIONS.

IF, from the violence of the inflammation, from the destruction of parts, or from whatever cause, adhesive union shall not take place, we must then endeavor to promote union by means of granulations. For this purpose

purpose the same indications should be observed as are laid down in Sect. 1.; excepting that, when the adhesive inflammation is passed, it is not necessary to take such pains to keep the soft parts in contact. The ligatures, if any have been applied, had better be removed. The means for reducing the inflammation should be persevered in, as assiduously as before: for although inflammation is necessary to suppuration, and suppuration is necessary for granulations to form, yet the less we have either of inflammation or suppuration the less will be the danger to the life of the patient, and the sooner will a cure be obtained.

Sometimes the injury not being very great, or in consequence of the propriety of the treatment, the inflammation will increase but slowly, and will be attended with no very considerable pain, spasm, or symptomatic fever; and in six or seven days, as the suppuration becomes free, will begin to diminish;

diminish ; and after a certain time, no accident happening, granulations will form, and gradually fill up the wound.

In these favorable cases very little is necessary to be done. Care should be taken that the operations of the economy, so far as they tend to the restoration of the limb, are not interrupted ; and they alone will be sufficient to restore the parts to an healthy state.

In these cases, the less there is done locally, the better. Some have a great dread of every thing that is greasy, and are very fond of cramming dry lint into the wound ; and I have even heard it asserted that the wound will not do well under any other mode of dressing. Others are as fond of introducing digestives, as they call them ; and suppose that suppuration cannot take place without those stimulating applications. These notions, however, I can from experience

rience say, are the effect of prejudice; and are often productive of mischief. It is more than probable that their advocates never tried any other means, nor ever recollected that the production of pus, and of granulation, is an operation of the living powers of the economy, and not of their applications.

In my humble opinion the dressings, during the inflammatory stage, should be quite superficial; such as are soft, lie easy upon the part, and are void of any stimulating quality. A common poultice seems the best application; for most other dressings, by absorbing the blood and coagulable lymph, become hard, and adhere firmly to the edges of the wound; when by their irritation they increase rather than diminish the inflammation.

After suppuration has commenced, and the tension has abated, the poultice should be left off; and if there is not a depending opening

opening for the pus to escape by as it is formed, a little dry lint, introduced very lightly into the cavity of the wound, will absorb a part of the pus, and thus lessen the danger of its escaping into the surrounding reticular membrane. For an application to cover the wound, a piece of lint, spread over with *cerat. alb.* is as good as any thing. When the fractured ends of the bone are exposed, and any of their *spiculæ* are observed to irritate the soft parts, they may be covered with a bit of lint. When it is observed that the discharge from the bones is very fetid, and acrid, as is sometimes the case, some dry lint applied to the bone as far as it is denuded, will absorb the discharge, and thus prevent its irritating the surrounding parts, which it is otherwise apt to do. It is not uncommon to meet with surgeons who are very attentive to apply dry lint over the denuded portions of bone,

in every case, and without having any reason to assign for it; as if the lint possessed some unknown specific quality by which it operated on them. I should not think it worth while disturbing this innocent prejudice, if I had not observed that sometimes so large a quantity is crammed in as by its bulk to press considerably on the surrounding parts, increasing inflammation and interrupting the process of healing; and that sometimes it is continued even where granulations are forming from the bone, when if the discharge is insufficient to moisten the whole lint, it adheres so firmly to them as not to be separable without violence, and frequently the surface of some of the granulations will be torn away with it.

But frequently cases of compound fracture occur which are less fortunate than those above described, and in which disagreeable symptoms arise that often terminate
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the life of the patient. These symptoms will vary in different people, from the difference in constitutions, and from the difference in the degree of violence the part has suffered.

There is always some pain, and some degree of symptomatic fever; though at times I have been surprized to find them both so slight. There is also a spasmodic twitching of the muscles, which is more or less in different cases, and which, generally, if somebody does not attend the limb, puts the patient in constant terror, and even prevents his sleeping, for fear he should inadvertently move it: if he gets into an imperfect sleep, one of these twitches coming on will cause him to awake with a sudden start, and a sensation as if he was falling from a precipice.

Sometimes there will come on, very soon after the injury, violent shooting and throbbing pain, the part becoming very tumid, and
violently

violently inflamed; the symptomatic fever increasing rapidly; the pulse full, hard, and quick; the skin hot and dry; the countenance florid; the tongue dry and furred; the urine pale, and in small quantity; frequently pain in the head and redness of the tunica conjunctiva, and sometimes costiveness.

These symptoms, if they are not moderated by local and general bleeding, and the antiphlogistic plan before laid down, will, in about two, three, four, or five days, terminate in another set, which mark extreme debility and irritation.

The pain becomes less throbbing, but more of a hot burning kind; and this also gradually ceases; the part becomes covered with small vesications; the tumefaction subsides; the redness gradually changes to a dark, livid color; and the part becomes flabby, and pits on pressure, and
loses

loses its sensibility. The fever also abates; the pulse becomes, at first, natural, but soon very weak, frequent, and at last irregular. The patient was before very restless on account of the pain, he now becomes more restless, though he cannot tell why. An unusual quickness, attended with a trembling, may be observed in all his actions; when spoken to, he answers as if in a hurry. To these succeed delirium, extreme debility, and death.

In some cases which I have seen, where the injury was very great; and principally in people who had been very irregular lives, and subject to frequent intoxication; the parts have not become so tumid as in the former case. The patient complained of a pain rather hot and burning than throbbing; so that the dressings, after they had been on a little while, seemed to scald him, attended with violent shooting pains, and
spasms

spasms of the muscles, and an extreme restlessness almost from the time of the accident: the pulse quicker than natural, but by no means so full as in the former case. Sometimes the restlessness is so great, that if the patient is not restrained by force, he will tear off all the dressings, and even get out of bed. Generally in two or three days the parts surrounding the wound are evidently gangrenous, when the pain will somewhat abate, and the patient be rather more composed; sometimes he gets a little sleep, but it is very disturbed, and he frequently awakes in a great fright and in a partial delirium; to this a complete delirium very soon succeeds. Generally the gangrene has continued spreading, the symptoms of debility and irritation, sometimes the delirium have continued increasing, until the patient was carried off. The living powers in these cases being previously in a
debilitated

debilitated state, seem incapable of going into those actions which are necessary for the restoration of the limb, they sink under it—they die almost without attempting it.

I have met with one or two cases, in seeming favorable subjects, where the violence done to the limb was very great; amputation was not performed, and the portion of the limb below the fracture died without any living action taking place in it. The inflammation in the wounded living part came on slowly, with very little tension, and with less pain and restlessness than in either of the former cases. The symptomatic fever came on very gradually, and was by no means violent; yet they sunk, apparently exhausted.

In the former of these cases it is hardly necessary to say, that the most powerful means should be had recourse to, without losing a moment, to moderate the inflammation. Bleeding, both local and general, should be

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employed freely, more especially the former: fomentations with opium; and emollient poultices with acetum lithargi, and opium. The limb should be kept perfectly still, free from pressure and all other causes of irritation. The body should be kept quiet, and in as easy a posture as possible; the mind free from irritation. The bowels should be kept open by gentle saline purgatives: the skin relaxed by antimonials, saline substances, and fomenting the extremities which are not injured, or by immersing them in tepid water. The air in the room should be cool. The diet sparing, and free from stimulus: and indeed all those means which are called antiphlogistic should be had recourse to, and should be continued until the inflammatory symptoms are removed.

But as soon as it is found that these symptoms are terminating in symptoms of irritation

tation and debility, the plan of treatment should be changed; for the principal indications then are,

To strengthen the living powers of the system; and

To remove its extreme irritability.

In the treatment after mortification has taken place, we ought, I am of opinion, to be regulated by the state of the system, and by the degree of inflammation in the surrounding parts. For notwithstanding that mortification has taken place, if the inflammation surrounding it is violent, and the symptomatic fever great, the antiphlogistic plan should still be continued. I think I have seen mischief done from want of an attention to this rule. It is not an uncommon practice, the moment gangrene is observed taking place, without attending to the state of the surrounding parts, or of the system, to apply stimulating medicines to the part, and

to throw stimulants, and cordials, into the stomach. This I have seen done when a small portion of the integuments only were mortified, while the surrounding parts were intensely tumid and inflamed; the patient raging with pain, and laboring under a violent symptomatic fever. The termination, as might naturally be expected, was in death.

The reason for this mode of practice I suppose must be, the dread of increasing that debility which is always attendant on mortification when the inflammation ceases. But it should be remembered that, in these cases, this method of treatment increases the inflammation; and the more the inflammation is increased the further will the mortification extend: besides, the inflammation will debilitate the system more than the means employed to reduce it.

As soon however as the tumefaction and pain in the part, and the symptomatic fever
begin

begin to abate, bark should be given in as large doses as the stomach will bear. Indeed, if the inflammation diffuses itself with a tendency to erisipelas, it may be given earlier, and may often advantageously be combined with opium. Neither of these remedies are so much to be dreaded in inflammation as some practitioners would lead us to suppose. Opium is often given with propriety to remove disagreeable symptoms in every stage of inflammation. Bark seems to operate by increasing the tone and living powers of the system; but I have never been able to observe any stimulant property by which it increases its actions. If, as I am humbly of opinion, it has no stimulant property, why should we be afraid to give it in those cases where we want to increase the living powers of the system, at the same time that we want to lessen the too violent action of a particular part? As the symptoms

toms of debility and irritation come on, the bark and opium should be given more frequently, if the stomach will bear them; the patient should also be allowed as much wine as he can take, and as much of a light, mild nourishing diet as will lay on the stomach.

If under these means the inflammation abates, and the mortification ceases to spread, the symptoms of irritation will abate; the pulse, tho' weak, will be slower, and more regular; the appetite for food will begin to mend, and the patient become more composed.

In cases answering to the second description, symptoms of debility and irritation come on almost immediately after the accident. The indications here from the first are, To strengthen the living powers of the system; and To remove its extreme irritability. Therefore, as soon as we observe these symptoms coming on, we should give
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the bark as frequently and in as large doses as the stomach will bear. Opium should be added to the bark, and its quantity increased as far as the patient can bear it. He should also be allowed, as in the former case, as much wine as he can take : indeed the treatment necessary in both cases is similar, the symptoms are so much alike.

Patients, in either of these kinds of cases, bear large quantities both of opium and of wine. I have seen a patient under a mortification after a compound fracture, take 12 drachms of bark, 240 drops of tr. opii, and three pints of wine, every twenty-four hours, for some days, and it produced scarce any visible effect on the head. This state of the disease so often proves fatal, and in so short a time, that when it occurs we are not justified only, but compelled by our duty to fly to the most powerful remedies. Bark, wine, and opium are the best and most powerful remedies we are at present acquainted

quainted with. They should be given in large doses, and repeated frequently; their effects should be closely watched, and the exhibition of them should be pushed as far as possible; otherwise the patient will not have that chance for his life to which he is entitled. The bowels should be kept open by glysters, or gentle purgatives. Every source of irritation should be avoided.

The diet ought to be very light, free from irritation, and easy of digestion.

With respect to the applications to the limb, in this stage of the disease, but little I believe in most cases ought to be expected from them: our principal attention should always be directed to support the living powers of the system, and by that means to prevent the spreading of the mortification. If there is violent local inflammation, local applications ought to be employed to reduce it, whatever may be the state of the system. I can see no impropriety in applying leeches,
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and other local means to reduce the inflammation in the limb, while we are giving bark to support the powers of the constitution.

If after the mortification has begun the inflammation is not violent, those means seem best which are best calculated to allay the irritable action which is then generally present.

It is an almost universal practice in this state of the disease to apply spir. terebinth. and other stimulants to the limb, to enable nature (as it is said) to throw off the diseased parts. But with all deference to the knowledge and experience of others, I think this is a very bad, nay in many instances a very dangerous practice. This kind of stimulants, as far as I have been able to observe, possesses a power simply of increasing action. Here is a want of living powers, not a want of action; in-
 somuch, that a degree of inflammation, which in an healthy subject can produce no bad
 Q effect,

effect, will degenerate into a diseased irritable action, and be too violent for the parts to support. We ought, therefore, in my humble opinion, to avoid stimulants, and every cause of irritation; to keep the limb perfectly still; and, by the application of gently astringent poultices, to endeavor in some measure to allay the irritation, and to keep the parts of their proper temperature. Every thing else must depend upon our increasing the powers of the constitution in general. If the mortified parts are very offensive, there can be no harm in scarifying them to let out the putrid fluid they contain; nor can there be any objection to the application of fragrant substances to the dead parts, or even to the dressings covering the limb, if it is the fancy of the surgeon, provided care is taken that they do not irritate the living parts.

If by the means above laid down the progress of the mortification shall be interrupted,

rupted, the irritable erisipaleous inflammation will cease to spread, and an healthy inflammation will be observed to take place round the margin of the dead parts, which will be followed by an ulceration, that begins at the surface and continues progressively until they are separated.

If the parts mortified are not very extensive, there may still be a possibility of saving the limb. But sometimes the mortification will extend thro' the whole limb, or so far that the loss of it will be inevitable; a large portion of muscular substance, or some of the large blood-vessels, being destroyed; or the extent of the wound may be so great, that the patient is in danger of sinking from the excessive discharge. But in all these cases, the operation should be deferred, if possible, until some time after the separation has begun, that the irritation of the system may be somewhat abated, and time be obtained to

make some attempts to recruit the strength. No rule, however, can be given, at what time the operation should be performed, in particular cases: it must be regulated by the peculiar circumstances attending them.

Provided the inflammation is not so great as to cause a mortification; or provided a mortification has commenced, and, the constitution being enabled to support it, the parts are separated, and the limb is so far likely to be saved; the next thing to which our attention must be directed is,

To prevent too great a formation of pus,

The quantity of pus will be in proportion to the violence of the inflammation, and to the extent of the surface from which it is secreted.

I have already spoken of the method of moderating the inflammation.

The extent of surface may arise from the wound being at first very extensive; or from
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the pus not having a free exit as it is formed, when by collecting it forms sinuses, abscesses, &c.

The method of lessening the original surface, I have already noticed, when speaking of the cure by adhesive inflammation.

When inflammation goes on very rapidly, the adhesive stage is so short, that there is not time for coagulable lymph to be thrown into the surrounding reticular membrane; that consequently is left open, and if the pus has not a free opening to escape by, it is very liable to insinuate by its gravity into the reticular membrane, and along the course of the muscles, exciting irritation and ulceration; thus forming other inflamed surfaces that produce pus. By this means sinuses and abscesses are formed in parts distant from the seat of the injury. In a compound fracture of the tibia, where the injury done to the soft parts was comparatively trifling,

fling, I have seen sinuses form which extended up to the knee, and down below the transverse ligament of the ankle. The best mean to prevent this accident appears to me to be, to retard the inflammation in the first instance as much as possible. For when the inflammation is long in going through its adhesive stage, a larger quantity of coagulable lymph is thrown out; and altho' it may fail in uniting the whole, or even a part of the surface of the wound, yet there is a greater chance of filling up the interstices of the surrounding reticular membrane, and by that means circumscribing the cavity of the wound, as is the case in common abscesses. But if we have not succeeded in this, we should let the wound be as depending as possible; or form a counter-opening, if it can be done, that the matter may be discharged as fast as it is formed.

Whenever sinuses, or abscesses form, they ought to be opened very early; by this
mean

mean we shall prevent their extending from the matter collecting in them.

At this time the symptomatic fever is gone off; the patient is generally much debilitated, and requires to be supported. Therefore, tonics, good air, cheerful company, a nourishing diet, and occasionally a small quantity of wine, or malt liquor, is necessary.

If notwithstanding these means the quantity of discharge continues so great that the patient is visibly sinking under it, amputation is necessary to save life. But we ought not to be in too great an hurry to remove the limb. I have seen cases where there were sinuses extending in different directions, attended with a great discharge, hectic fever, loss of appetite, with symptoms of general irritation in the system, and the patients appeared to be sinking very fast: yet, upon laying the sinuses open, and giving
bark

bark internally in pretty large doses, an almost instantaneous change has taken place; the symptoms of irritation have abated, the appetite has returned, and the sinuses healed in a very short time. In a case where there were sinuses extending from the anterior-superior part of the tibia down to the foot, they were opened as far down as the transverse ligament, and the pus being carefully pressed out, the parts were brought into contact, when they completely united by adhesive inflammation. But when the parts are much changed in their structure from the long continuance of the disease, so rapid a cure cannot be expected.

However, if after having done every thing that art can point out, the discharge still continues great, with symptoms of irritation, and with strength and appetite gradually diminishing, the operation ought not to be deferred too long; for the patient may become

come so reduced as not to be able to bear the shock consequent upon it. If the patient is able to support the operation, and labors under no other disease than what is symptomatic of the disease in the limb, we shall generally, in two or three days after the operation, observe a change for the better. The hectic fever will abate; the appetite begin to mend; the strength will visibly increase; and the sleep, which before is imperfect and interrupted, will now become sound and refreshing.

Now and then the bone continues disunited, in compound fractures, for a considerable time after the accident has happened; the discharge not very excessive, but thin, ichorous, and fetid; with one or more small orifices leading externally; and attended with considerable irritation in the system, which sometimes gradually sinks under the disease. This may occur in every

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diversity of constitution; but I believe is most frequent in those constitutions which are very irritable, or have a tendency to scrophula.

If the patient in these cases is very much exhausted, it is better in the first place to attempt the recruiting of his health and strength. This may often be accomplished by the use of tonics, and by a change of air and diet.

The wound should then be examined. When there are several openings leading to the fracture, they should, if their situation admits of it, be laid into one. If there are any sinuses, they also should be laid open: when that is impracticable, counter openings should be made into them. The bones should be carefully examined. Sometimes one or more loose fragments are found, which were the cause of the irritation and consequent diseased action: but more frequently

quently a piece of exfoliated bone being retained, prevents the process of healing. Sometimes, in the very compact bones, when a considerable portion of the bone is killed, the process of exfoliation is very slow, and the irritation produced in the system by the surrounding inflammation is so great, that the patient gradually sinks under it; and, as the powers of the system lessen, the process of exfoliation goes on slower. But the most frequent cause of this state of disease seems to be, a partial death (if I may be allowed the expression) taking place in the bone, in consequence of the circulation being stopped by its vessels being torn through. Thus a large artery, the medullary artery for instance, being divided, the circulation is totally cut off through a part of the bone, and it immediately dies, and soon after the exfoliation of it begins. In another part of the bone, the circulation is not entirely cut

off; it is sufficient to support life for some time. But the circulation and living powers being both very weak, a very slight cause puts a stop to them; so that the inflammation extending from the surrounding parts, or any other accidental cause, produces the death of the bone. As this sometimes happens in different parts at different times, we now and then meet with tedious exfoliations taking place successively.

If we find any fragments, or loose exfoliated pieces, they ought to be removed. If there seems to be a large portion of bone exfoliating, and we think the operation and consequent discharge not too great for the patient to sustain, I think it better to trace the exfoliating bone through its extent, and by the application of the trephine, if it appears necessary, and of gentle stimulants, such as tr. myrrh., spir. vin., &c., attempt to increase the action of the absorbents in the
living

living part to which it is in contact. When a portion of bone seems to possess such weak living powers that in all probability it will die and exfoliate, the process will be very much forwarded by cutting off the circulation and killing the part at once. Various means have been recommended for this purpose; but the best and safest way seems to be, to make a number of perforations, so as almost to separate it from the more vigorous part.

After the sinuses have been opened, and the exfoliations have ceased, we shall generally find that a more healthy action will commence; that the parts will gradually assume their natural appearance, and the discharge become good pus. The health at the same time will mend; the granulations will assume an healthy appearance, and by degrees fill up the wound.

Sometimes however, notwithstanding all that we can do to retard it, the patient's strength

strength continues declining, and the extent of the diseased part is so great, that it is a safer practice to remove the limb than hazard his life by an operation the success of which is so uncertain, and in a case where the actions of the economy are so slow that, if it should exceed our most sanguine expectations, yet it must be a long time before a cure can be effected.

Sometimes the inflammation in the bone becomes too great, and extends through its whole length, causing an increase of its bulk, and sometimes an increased deposit of ossific matter, lessening the tendency to granulate; and frequently attended with a very offensive discharge, an obtuse pain along the course of bone, with considerable irritation, debility, and emaciation of the system. The progress of this bony inflammation is very slow; sometimes, if the patient survives, continuing for many years. In this case
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the weakness of the living powers in bone seems very evident. An inflamed action is brought on, which the powers of life are incapable of conducting to its natural termination. It has little tendency to diminish or resolve, still less to suppurate; and in general the bone possesses too much living power for it to terminate in death. It therefore continues nearly stationary; and the bony matter being generally deposited faster than the absorbents remove it, the bone, as far as the inflammation extends, becomes remarkably increased in size, weight, and solidity. Now and then this bony inflammation extends to the reticular membrane, and even to the other surrounding parts, changing them into a bony substance.

Fortunately, however, the diseased state of the bone, of which we are now speaking, very rarely occurs in consequence of compound fractures.

In these tedious cases, the limb below the fracture generally undergoes a considerable change. Being kept continually in a state of rest, the circulation becomes languid, and the muscles not being supplied with a due proportion of nutriment generally lessen in bulk, and sometimes to a very great degree, and the limb is generally below its natural temperature. This ought to be no objection to our endeavoring to save the limb; for if we succeed, on the part being again put in motion, the action of the muscles will again increase the force of the circulation through them, and in time they will acquire their former size.

A case of compound fracture came under my care, a few days since, where the limb instead of becoming smaller had increased to an enormous size. It was a compound fracture of the humerus near to the insertion of the deltoid muscle, and had happened
about

about eighteen months before. A considerable portion of each broken extremity of the bone had exfoliated, but not having been removed the process of healing could not go on. A considerable quantity of coagulable lymph was thrown into the soft parts around the fracture; had almost destroyed their natural structure, and had rendered them so firm that the bone seemed as if surrounded with cartilage. From the elbow downward the limb was amazingly but uniformly distended, with an elastic, slightly edematous feel.

On dissection, the muscles were found of a florid-red color; and they appeared to be full as large as those of the other arm, if not larger. The cellular membrane covering them was of a great thickness, containing coagulable lymph and adeps principally, with a small proportion of water.

FINIS.

